United States Patent

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[54] **APPARATUS FOR POSITIONING A FINISHING SCREED MEMBER IN A ROAD PAVING MACHINE**
5 Claims, 11 Drawing Figs.

[52] U.S. Cl. .... 94/46 AC
[51] Int. Cl. E01c 19/48
[50] Field of Search .... 94/45, 46, 46 A

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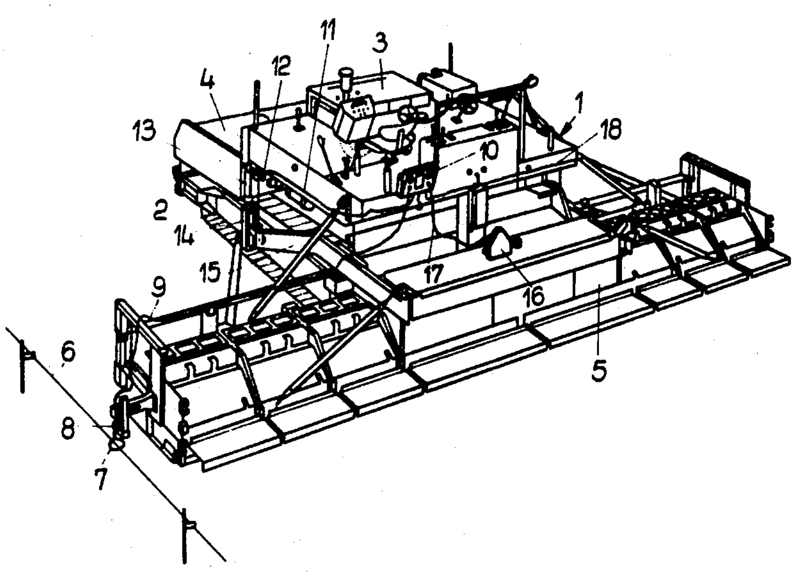
ABSTRACT: In a road-paving machine, surfacing material is deposited on a subbase and a finishing screed board spreads and finishes or levels the surface of the material to the proper grade and plane. Test feelers are mounted on the screed board to detect any deflections from a reference position, though the machine causes vibration, the test feelers are arranged to measure the actual deflection and to signal the extent of the deflection to a regulating instrument for correcting the position of the screed board in accordance with the deflections measured.



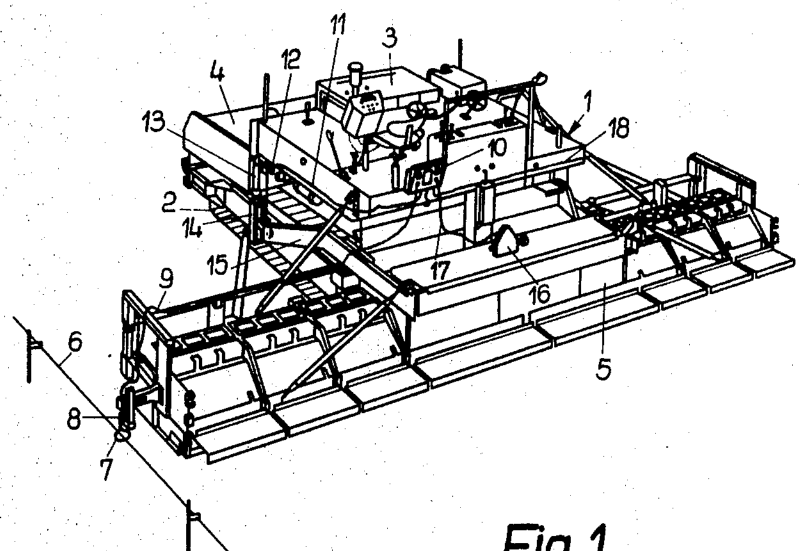


Fig. 1

Fig. 2

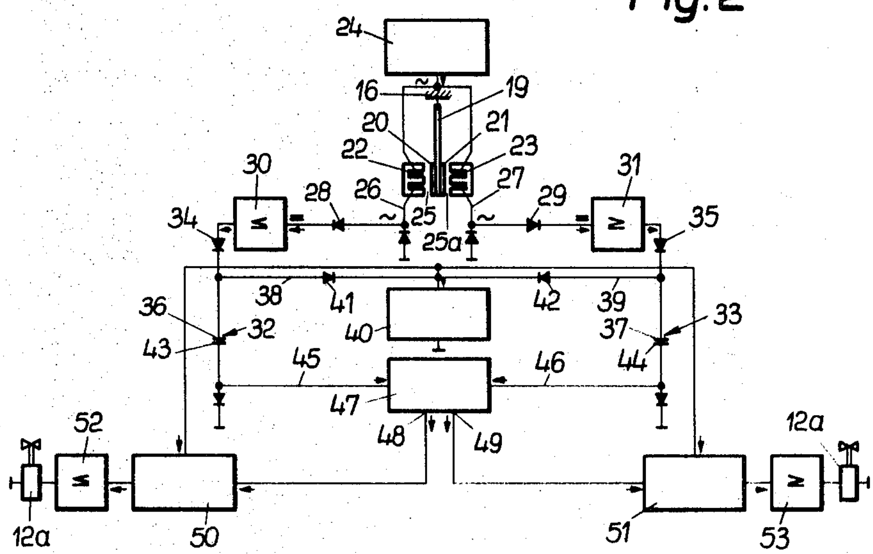


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Fig. 3

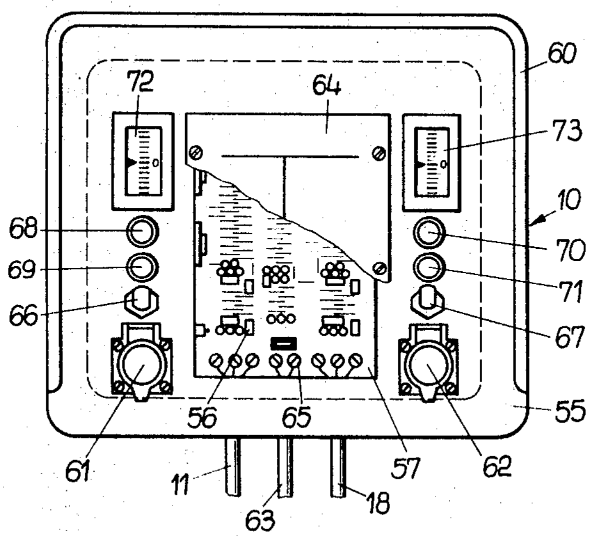
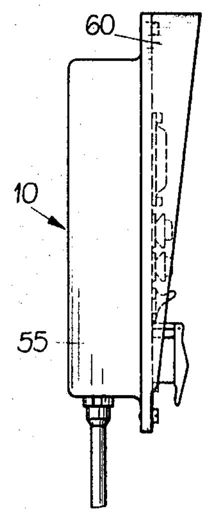


Fig. 4



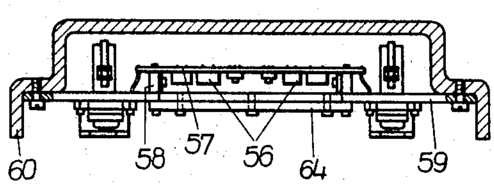


Fig. 5

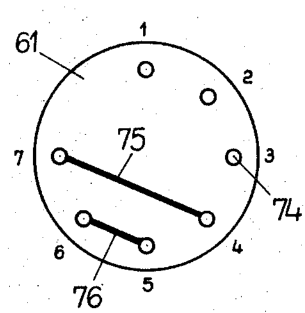
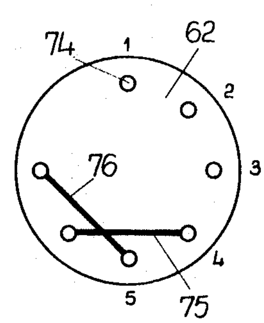


Fig. 6

Fig. 7



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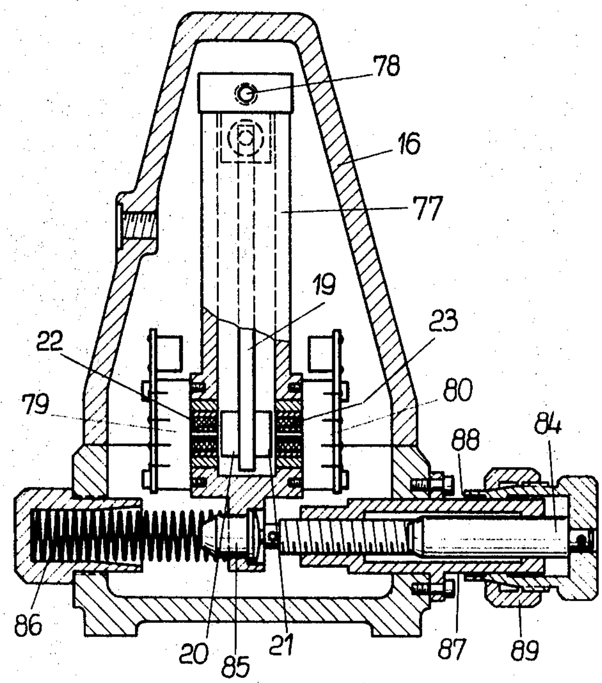

Fig. 8

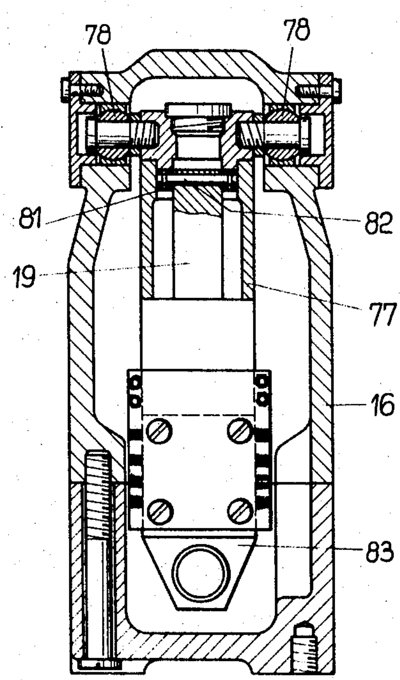

Fig. 9

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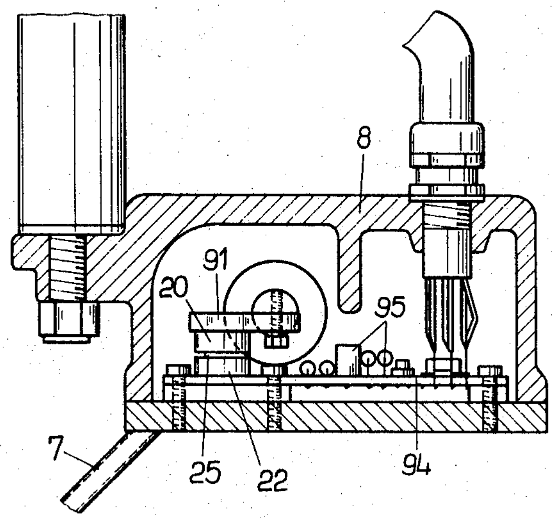
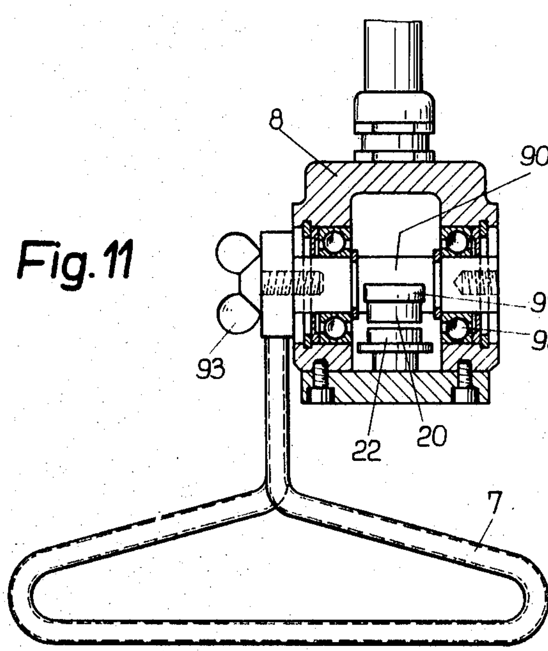


Fig. 10

Fig. 11



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APPARATUS FOR POSITIONING A FINISHING SCREED MEMBER IN A ROAD PAVING MACHINE

SUMMARY OF THE INVENTION

The present invention is directed to a method of and apparatus for positioning the screed board in a road paving machine for accurately finishing the surface of the surfacing material being used and, more particularly, it is directed to devices for determining any deflection of the screed board from a reference position and to means cooperating with the sensing devices for reestablishing the screed board in the proper reference position. Further, the invention concerns the use of sensing devices, for determining the deflections, which generate electrical voltages proportional to the extent of the deflections of the screed board and by means of the voltages the extent of the deflection is measured and the proper adjustments made.

Devices for leveling or positioning the finishing members in road-paving machines have been known in which a sensing device for determining transverse inclination of the finishing member, such as a pendulum, and a sensing device for establishing the longitudinal level or slope of the finishing member, such as a scanner moving along a pilot wire, are tapped electrically by means of potentiometers for transmitting variable voltage values to adjusting devices for properly aligning the finishing member. In such arrangements, the test scanning points were designed as slide contacts moving along a resistor coil which produced, due to the changes in resistance, the voltage changes used for control purposes. These sensing devices can function perfectly only when attached to the finishing member itself and, as a result, they are exposed not only to the vibrations of the drive system of the road-paving machine, but also to the considerably stronger vibrations of a shaking device used in combination with the finishing member. Accordingly, it is unavoidable that the sensing members experience severe and undesired vibratory movements. For instance, it has been established that the pendulum-type sensing device swings back and forth continuously during operation due to the undesired vibratory movements and that the scanning device constantly dances on the reference wire. As a consequence, the adjusting elements for the finishing member, such as magnetic valves for hydraulic adjustment cylinders, are constantly being reversed with the result that the accurate positioning of the finishing member is questionable and the reversing action contributes greatly to the wear of the adjusting elements. In attempting to reduce the effect of the undesired vibrations, known sensing devices have been mounted in oil. While this compensating action effected an attenuation of the undesired vibrations, it also served to attenuate the actual deflections of the finishing member and there was a tendency to considerably retard such actual deflections, so that any deviations from the actual pavement surface contour could not be adjusted in time to correct the surface imperfections. Therefore, the flatness or desired planar contour of the pavement surface which is attainable with equipment presently in use is no longer adequate, especially in view of the steadily increasing requirements for accuracy. An improvement in the sensitivity of the response of the sensing equipment cannot provide any assistance either, because the influence of the vibratory shaking motions reasserts itself to an increasing degree.

Accordingly, the present invention solves the problem of the undesired vibrations by completely supressing them without experiencing any retardation response as has been the case in the prior art equipment.

Therefore, in accordance with the present invention, the superposed alternating voltages caused by the vibrator means in the road-paving machine are suppressed in establishing the actual deflections of the finishing member or screed board from a reference position. In attaining the suppression of the vibrations the values of the crest voltages and the trough voltages of the sensing device deflecting laterally on both sides of a zero point, as in a pendular action, and the peak voltages associated with a sensing device deflecting from a zero-point to one side only, such as in a scanner gliding on a guide or reference wire, are stored in capacitors or the like and these voltage values are measured subsequently and discharged in time intervals greater than the time period of one cycle of the superposed machine vibrations, with the voltages obtained in the deflection of the sensing devices yielding the measure of the actual deviation of the finishing member in vibrationless operation. By establishing the mean value of the crest and trough voltages in the pendular action and by utilizing the peak voltages obtained in the scanning action along the guide wire, all disturbing shaking and vibratory movements of the road-paving machine can be excluded completely so that only the actual deviations which occur at completely vibrationless operation of the machine are transmitted to the adjusting devices for orienting the finishing member or screed board in the proper reference position. Therefore, great accuracy, which has not been attainable in the past, is achieved in the finishing of the pavement surfaces.

Where the sensing device is a pendulum-type member, the crest and trough voltages are registered separately and a mean value is established from these voltages, the voltage value for the actual deflection vibrationless operation results within one vibration cycle of the machine, with the result that the adjusting member responds promptly without any retardation or error, and also without any regard for the size of the vibration amplitude generated in the machine. Where a scanner sensing device is used, the peak voltages associated with the movement of the scanner relative to the wire yield the measure of the actual deflection of the screed board and also can be used within one vibration cycle for establishing the necessary response from the adjusting member.

In implementing this method of deflection measurement where a pendulum-type sensing device is utilized, a pair of test recorders are used for sensing the opposed deflections of the device on both sides of a zero point. The crest voltages established by the sensing device are communicated to a capacitor which stores the crest voltages and whose input side is connected to a common pulse generator which establishes the control time period for checking the deflections. The output side of the capacitor is connected to a differential amplifier for determining the voltage differential during the control cycle, with one output terminal of the differential amplifier being connected to a pulse storage member for retaining the positive deflections of the sensing device and its other output terminal being connected to a pulse storage member retaining the negative deflections of the sensing device for the next control pulse. The pulse storage members acting via the amplifiers upon the adjusting members for effecting the proper positioning of the finishing member or screed board. A similar arrangement as is used for the pendulum-type sensing device deflecting to both sides from a zero point, can also be applied to the sensing device which deflects between a zero point and one side only, such as a scanner device gliding along a guide wire in which a reference voltage source is incorporated in place of one of the recorders for determining the differential voltage established.

Since a sensing recorder is positioned on each side of the pendulum-type sensing member and scans opposed sensing member deflections, one of the recorders passes on the crest voltages while the other recorder passes on the trough voltages in the form of crest voltages phase-shifted by 180°. By comparing the two crest voltages, the value of the actual deflection of the screed board of a road-paving machine from a reference position at vibrationless operation can be established in a simple manner from the differences between these two voltages. To permit the transmission of the actual deflections from the reference position, to the adjusting member, with as little delay as possible, the comparison of the two crest voltages is made by a pulse generator in a time period equivalent to one vibration cycle of the lowest vibration frequency. By continuously comparing the two crest voltages after each vibration cycle it is possible to transmit to the adjustment members the smallest deviations which take place virtually immediately after they are sensed.

The various features of novelty which characterize the invention are pointed out with particularity in the claims annexed to and forming a part of this specification. For a better understanding of the invention, its operating advantages and specific objects attained by its use, reference should be had to the accompanying drawings and descriptive matter in which there is illustrated and described a preferred embodiment of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings:

FIG. 1 is a perspective view of a road-paving machine which spreads and finishes the surface of a blacktop surfacing material, embodying the present invention;

FIG. 2 is an electrical wiring diagram for the adjusting equipment shown in FIG. 1;

FIG. 3 is a front view of a regulating instrument incorporated in the road-paving machine illustrated in FIG. 1;

FIG. 4 is a side view of the regulating instrument shown in FIG. 3;

FIG. 5 is a top sectional view of the regulating instrument shown in FIG. 3;

FIGS. 6 and 7 illustrate the two receptacles or sockets of the regulating instrument arranged to receive plugs;

FIG. 8 is a front view, partly in section, of a pendulum-type sensing device;

FIG. 9 is a transverse sectional view of the sensing device shown in FIG. 8;

FIG. 10 is a sectional front view of a scanner-type sensing device; and

FIG. 11 is a transverse sectional view of the sensing device shown in FIG. 10.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

In FIG. 1, a road-paving machine 1 is shown for depositing a layer of blacktop material on a subbase and for finishing the surface of the blacktop material to the desired grade and transverse configuration. The machine consists of a caterpillar running gear 2 which is actuated by a drive system 3. From a container 4 on the machine, the blacktop material is distributed by a worm, not shown, onto the subbase of a roadway and a finishing member or screed board 5 shapes the surface of the pavement to the desired configuration. The screed board is equipped with a vibrator mechanism to obtain the required compression of the blacktop material.

For guiding the machine 1 and its screed board 5, a wire is aligned along one side of the machine adjacent the end at which the screed board 5 is located. The scanning member controls the attitude of the screed board for providing the finished surface on the pavement. The scanning member 7 is pivoted in a housing 8 which contains built-in components for transmitting the angular position of the scanning member electrically to a regulating instrument 10 via a cable 9.

If the caterpillar tracks 2 of the machine 1 pass through a depression the scanning member changes its angular position and this change is transmitted to the regulating instrument 10 which opens one valve of a magnetic valve unit 12 by way of the electrical line 11. By means of the action of the valve, a hydraulic adjustment cylinder 13 is retracted and raises the screed board which is suspended in joints from a bearing 14 by means of crossarms 15. Consequently, additional blacktop material is deposited between the subbase and the screed board so that the finished surface of the blacktop is at the desired level in spite of the depression in the subgrade. Conversely, if the caterpillar track 2 rides over projections in the subgrade, the deflection sensed by the scanning member 7 reverses the action as indicated above causing the adjusting cylinder 13 to extend for providing the necessary amount of blacktop to form the finished surface at the desired level. The adjusting cylinder on the opposite side of the machine 1 is not shown in the drawing and is controlled by a pendulum-type assembly positioned within a housing 16 which is supported on top of the screed board 5 intermediate the sides of the machine and maintains the screed board in a reference position relative to the position of the scanning member 7. Deflections of the screed board from the reference position are transmitted from the housing 16 by way of line 17 to the regulating instrument 10, which actuates the right-hand magnetic valve unit 12*a* and its corresponding hydraulic adjusting cylinder to respond via line 18.

In FIG. 2, an electrical wiring diagram is illustrated which indicates the manner of operation of the device for positioning the screed board through the action of the pendulum-type member 19 which acts as a test or sensing member and deflects to both sides of a zero point. The pendulum-type member 19 is pivotally mounted in the housing 16 and at its lower freely swinging end it has two ferrite tips 20, 21 which act upon two high frequency coils 22, 23 wound on ferrite cores and spaced in juxtaposition to the ferrite tips. The coils 22, 23 are fed by the high-frequency generator 24. As the pendulum member swings, the airgaps 25 and 25*a* between the tips 20, 21 and the juxtaposed coils 22, 23 vary, and the inductance of coils 22, 23 change so that a variable electric current flows in the lines 26, 27. The closer the pendulum-type member 19 and its respective tips 20, 21 approach the coils the narrower are the airgaps 25, 25*a* and the current flowing through the lines 26, 27 becomes smaller. As the pendulum-type member pivots in accordance with the variation of the screed board from its reference position, its deflections can be measured, without establishing any contact, as modifications in the current. As the pendulum-type member deviates from the zero point, a current decrease will take place in one of the coils and a current increase in the other so that the positive and negative current deviations are available for determining the position of the member 19. The current flow through the coils 22 and 23 is of such a small magnitude that a magnetic attraction of the pendulumlike member 19 does not take place. To rectify the high-frequency signal, the lines 26 and 27 pass through the diodes 28, 29 respectively, and then into the amplifiers 30, 31.

From the amplifiers 30, 31 the crest voltages generated in the coils are passed into capacitors 32, 33. Diodes 34, 35 are positioned between the amplifiers 30, 31 and the capacitors 32, 33, respectively, to prevent any undesired discharge of the capacitors. The input sides 36, 37 of the capacitors are connected by way of the lines 38, 39 to a common pulse generator 40 and diodes 41, 42 are located in the lines 38, 39, respectively to guarantee the separation of the two circuits. The pulse generator 40, at a frequency below the lowest frequency of the machine vibrations caused by the equipment for vibrating the screed board to effect the desired compression of the material being paved, such as in time intervals of 200 milliseconds emits very short pulses, such as of 2 milliseconds, which for restoration put the input sides 36, 37 of the capacitors 32, 33 on a zero potential by way of the diodes 41, 42. As a result, at the output sides 43, 44 of the capacitors, negative pulses, the magnitude of which correspond to the crest voltages of the pendulum deflections, are stored in the capacitors. The amplifiers 30, 31 are designed to withstand the short circuit which takes place.

Through the lines 45, 46, the output sides 43, 44 of the capacitors are connected to the two inputs of a differential amplifier 47. Within the differential amplifier the two pulse voltages being delivered are compared while the capacitors 32, 33 are discharged simultaneously, and when a difference develops the positive or negative differential voltages are amplified and conducted to the two stage flip-flop circuits 50, 51 from outputs 48, 49 of the amplifier 47. The two circuits 50, 51 are connected to the pulse generator 40 and are brought by the pulse generator into the rest position with every control pulse, provided the differential amplifier does not emit a control signal. However, if the differential amplifier does emit a control signal to either the left or right circuit, 50, 51, respectively, the corresponding circuit reverses to the working position and causes one of the valves of the magnetic valve unit 12a to respond through the related output amplifier 52, 53. The magnetic valve remains in the working position until another control signal arrives and charges the corresponding adjusting cylinder in either the upward or downward direction. A wiring diagram similar to that in FIG. 2 can also be utilized for the scanning member which moves along the guide wire 6, if a constant voltage is supplied to a connection instead of the deflection recorder or coil 23, which also includes the amplifier 31 and the diode 29. Preferably, the magnitude of the constant voltage corresponds to half the response range of the coil 22 with amplifier 30. For example, if the response range of the measuring recorder or coil 22 is between 0 and 12 volts, the constant voltage applied amounts to 6 volts so that positive and negative differences result.

In FIGS. 3 to 5, the regulating instrument 10 mounted on the machine 1 consists of a housing 55 in which an electronic evaluation circuit is positioned. All of the electronic components 56 for the evaluation circuit are soldered to a circuit board 57 having an etched circuit which is attached by strips 58 to a front plate 59 of the regulator. The front plate 59 closes off the face of the housing and the protruding housing rim 60 serves as protection for the operating and indicating devices which project from the front plate. The cable 9 which leads from the housing 8 of the scanning member 7 and the cable 17 which leads from the housing 16 of the pendulum-type member can be plugged into the receptacles 61, 62 on the front of the housing 55. A line 63 extending downwardly from the housing connects the regulating instrument to its power source, and lines 11 and 18 lead to the magnetic valve units 12, 12a which are actuated in the adjustment of the orientation of the road-paving machine. Adjacent the components 56, the front plate 59 has a cutout which may be closed by a screw-on cover plate 65. By this arrangement the components 56 and terminals 65 are easily accessible.

Toggle switches 66, 67 located on front plate 59 of the regulating instrument 10 serve to convert from automatic control of the positioning of the machine to manual control. The lifting and lowering adjustments under manual control are made possible by the push buttons 68, 69 and 70, 71. By actuating one of the pushbuttons 68, 69 the valves of the magnetic valve unit 12 on the left-hand side of the road-paving machine, as shown in FIG. 1, are charged while the valves of the other magnetic valve unit 12a on the opposite or right-hand side of the machine are actuated by the pushbuttons 70, 71. Indicating instruments 72, 73 are connected to the amplifiers 30, 31 and the deviations from the reference position of the screed board can be read on these instruments.

As shown in FIGS. 6 and 7, the receptacles 61, 62 are designed so that the plug of cable 17 leading from the housing 16 of the pendulum-type member 19 can be plugged into either of the receptacles 61, 62 without any special conversion or changeover being necessary. Similarly, these receptacles 61, 62 may be used in combination with a pair of scanning members 7 located along opposite sides of the machine instead of a single scanning member and a single pendulum-type member, as is shown in FIG. 1. To provide this advantageous arrangement, the receptacles 61 and 62 have 7 contact sleeves or sockets, numbered 1 through 7, which is two more than are required for the connection of the cable 9 from the scanning member or the cable 17 from the pendulum-type member. The contact sockets 1 to 5 are intended to receive the five contact pins of the plug of the cable 9 while the five contact pins of the plug of the cable 17 are intended to fit into the sockets 1, 2, 3, and 6, 7 of receptacles 61, 62. The sockets 4 and 5 of the receptacles are in conductive connection with the sockets 6 and 7 by way of the conductors 75 and 76, in receptacle 61 socket 4 being connected with socket 7 and socket 5 being connected with socket 6. However, in receptacle 62 socket 4 is connected to socket 6 and socket 5 to socket 7 so that the correct contact, that is, to the proper side of the finisher, is made automatically by inserting the plug of the cable from the pendulum-type member into the receptacle.

The arrangement of the housing 16 and the pendulum-type member 19 is shown in FIGS. 8 and 9. The pendulum-type member 19 is positioned in a box 77 which is supported in the housing on a pendulum bearing 78. At the lower or free swinging end of the pendulum-type member 19, that is, the end having the ferrite tips 20, 21, the high-frequency coils 22, 23 are mounted in the walls of the pendulum box 77. Outside of the box 77, adjacent the coils 22, 23, electrical circuit components 78, 80 are attached to the box and have, on a printed circuit board, the electronic components required for the amplifier circuit of the coils or recorders 22, 23, respectively. The pendulum-type member 19 is mounted on ball bearings 81 and pivot pin 82 so that it can swing freely in a pendular action within the box 77. At its lower end, the pendulum box 77 has an adjusting lug 83 so that the box can be positioned to a desired inclination of the surface of the pavement, that is to pitch in the lateral direction for curves or to provide a crown in the roadway surface. The desired reference inclination or position is set by means of the manual adjustment spindle 84 which engages the adjustment lug of the box 77 through a bolt 85. A spring 86 biases the adjustment lug constantly against the end of the spindle 84 so that no backlash can develop. The extent of the slope of the box is established by a scale 87 and a graduated ring 88 which moves with the spindle 84. A locking ring 89 is provided to fasten the adjustment device.

In FIGS. 10 and 11, the scanning member 7 and its housing 8 is shown in greater detail. Located in the housing 8 is a shaft 90 which supports an arm 91 at its center with the ferrite tip 20 for the high-frequency coil 22 being attached to the arm 91. The shaft 90 is supported in two ball bearings 92. A thumb screw 93 permits the scanning member 7 to be screwed into one or the other of the sides of the shaft 90 so that the scanning member may be used on either side of the road-paving machine. The movements of the scanning member, as it passes along the guide wire 6, causes the airgap between the ferrite tip 20 and the coil 22 to increase or decrease so that, as with the pendulum, the inductance of coil 22 changes. The coil 22 is positioned in the housing 8 on a printed circuit board 94 which contains electronic components 95 for the amplifier circuit of the scanning member and the voltage divider for the comparative voltage.

I claim:

1. In a road-paving machine for depositing a surfacing material on a subgrade and including a screed board which is exposed to vibrations having a determinable time cycle and said screed board arranged in a reference position for shaping the surface of the deposited material to a selected configuration, and equipment for maintaining said screed board in the reference position, said equipment comprising a movably mounted sensing member for measuring deflections of said screed board from the established reference position, wherein the improvement comprises that said sensing member is pendulously mounted for movement to both sides of a zero point, recording means spaced on each side of the free end of said sensing member for recording the extent of the deflections of said sensing member from the zero point as modifications in electric current, a capacitor connected electrically to said recording means on each side of the free end of said sensing member for storing voltages reflecting maximum deflection of said sensing member from the zero point, a common pulse generator connected to the input sides of said capacitors for establishing a control cycle, a differential amplifier connected to the output sides of said capacitors for determining the differential in voltage at the termination of the control cycle, a first pulse storage member and a second pulse storage member, one output of said differential amplifier being connected to said first pulse storage member for retaining positive deflections and the other output from said differential amplifier being connected to said second storage member for retaining negative deflections of said sensing member for the extent of the control cycle, amplifiers connected to said first and

second pulse members, and adjustment members being actuated through said amplifiers for adjusting the screed board to the desired reference position.

2. In a road-paving machine, as set forth in claim 1, wherein said sensing member being mounted on said screed board at a location intermediate the ends thereof.

3. In a road-paving machine, as set forth in claim 1, wherein said recording means comprises a pair of high-frequency coils each wound on a ferrite core and each located on one of the sides of the free end of said sensing member, a ferrite tip located on each of the sides of the free end of said sensing member positioned opposite said coils for modifying the current flowing from said coils in relationship to the gap between said ferrite tips on said sensing member and said coils as said sensing member swings on either side of the zero point between said two coils.

4. In a road-paving machine, as set forth in claim 1, wherein said equipment for maintaining said screed board in the reference position comprises a second sensing member positioned at one end of said screed board and arranged to deflect angularly in response to the deflections of the screed board from the reference position, and a second recording means comprising a high-frequency coil wound on a ferrite core and a ferrite tip arranged in spaced relationship from said coil and arranged for displacement relative to said coil, and means connected electrically to said coil for storing voltages reflecting the maximum deflection of said second sensing member from the zero point.

5. In a road-paving machine, as set forth in claim 1, characterized therein that a regulating instrument is supported on said road-paving machine, a housing incorporating said regulating instrument, receptacles in said regulating instrument housing for receiving electrical cables, and cable means extending from said sensing member and said second sensing member to said receptacles for conveying the signals establishing the extent of deflections of said screed board member to said regulating instrument.